WHAT IS CLAIMED IS:

1. A method for making an inorganic/organic hybrid nanolaminate barrier film, comprising:
combining an alkoxide, an alcohol, water dilute HCl and heating the resulting mixture. Introducing a coupling agent to the mixture,
introducing a surfactant to the mixture in a quantity sufficient that the initial surfactant concentration is below the critical micelle concentration;
adding to the mixture one or more polymer precursors suitable for the formation of a polymer selected from the group of, polyethylene naphthalate (PEN), polyether etherketone (PEEK), polyether sulfone (PES), fluorinated or non-fluorinated styrene polymer precursors, fluorinated or non-fluorinated methyl styrene polymer precursors, fluorinated or non-fluorinated (meth)acrylate polymer precursors, and combinations and/or derivatives of two or more of these precursors;
adding a cross-linker agent and an initiator to the mixture;
coating a substrate with the mixture; and
allowing the alcohol to evaporate so that the sol forms a film having alternating organic and inorganic layers.

2. The method of claim 1 further comprising incorporating one or more hydrophobic groups into the polymer precursors or eliminating one or more hydrophobic groups from the polymer precursors to increase and/or decrease the hydrophobicity of the organic layers.

3. The method of claim 2 wherein the one or more hydrophobic groups are selected from the group of non-polar hydrophobic groups, methyl groups, benzyl (aromatic) groups, PO_4^{3-}, SO_4^{2-}, CH_3COO^-, Cl^-, Br^-, NO^-, ClO_4^-, I^-, SC_n^- anions, NH_4^+, Rb^+, K^+, Na^+, Cs^+, Li^+, Mg^{2+}, Ca^{2+}, Ba^{2+} cations, tryptophan, isoleucine, phenylalanine, tyrosine, leucine, valine, methionine, alanine

4. The method of claim 3 wherein the surfactant includes one or more Gemini surfactants.

5. The method of claim 1 wherein the alkoxide includes tetraethylorthosilicate ($Si(OCH_2CH_3)_4$ and the alcohol is ethanol..

6. The method of claim 5 wherein in molar ratios of the tetraethylorthosilicate, ethanol, water, and HCl are present in the mixture in molar ratios of $1:3.8:1:5X10^{-5}$ respectively.

7. The method of claim 6, wherein the coupling agent is 7-octenlytrimethoxysilane, or methacryloxypropyl trimethoxysilane.

8. The method of claim 7 wherein the surfactant is cetyltrimethylammonium bromide.

9. The method of claim 1 wherein the one or more polymer precursors include 2,6-Dimethylnaphthalene, or a set of monomers such as bisphenol A and di-*para*-fluorophenylsulfone.

10. The method of claim 1, further comprising annealing the film at a temperature of about 125° to about 150°C or greater and/or below the lowest decomposition temperature of any of the organic materials in the film.

11. The method of claim 1 wherein coating a substrate with the mixture includes depositing the mixture on the substrate by dip coating, spin coating, spray coating, web coating, or microgravure web coating.

12. An inorganic/organic hybrid nanolaminate barrier film, comprising:
a plurality of layers of an inorganic material; and
a plurality of layers of an organic material chosen from the group of polyethylene naphthalate, polyether etherketone, polyether sulfone, polymers formed from fluorinated or non-fluorinated styrene polymer precursors, fluorinated or non-fluorinated methyl styrene polymer precursors, fluorinated or non-fluorinated (meth)acrylate polymer precursors, and combinations and/or derviatives of two or more of these precursors;
wherein the layers of organic material alternate with the layers of inorganic material.

13. The barrier film of claim 12 wherein the total number of organic and inorganic layers in the film is between about 100 and about 1000 layers, or between about 1000 and about 10,000 layers, or between about 10,000 layers and about 100,000 layers.

14. The barrier film of claim 12 wherein each of the layers of inorganic material has a thickness of about 0.1 nm to about 1 nm; about 1 to about 10 nm; or about 1 nm to about 100 nm.

15. The barrier film of claim 14 wherein the barrier film is substantially transparent.

16. The barrier film of claim 12 wherein the barrier film has a permeability to oxygen less than about 1 $cc/m^2/day$, 0.1 $cc/m^2/day$, 0.01 $cc/m^2/day$, 10^{-3} $cc/m^2/day$, 10^{-4} $cc/m^2/day$, 10^{-5} $cc/m^2/day$, or 10^{-6} $cc/m^2/day$.

17. The barrier film of claim 16 wherein the barrier film has a permeability to water vapor less than about 1 $g/m^2/day$, 0.1 $g/m^2/day$, 0.01 $g/m^2/day$, 10^{-3} $g/m^2/day$, 10^{-4} $g/m^2/day$, 10^{-5} $g/m^2/day$, or 10^{-6} $g/m^2/day$.

18. The barrier film of claim 12 wherein one or more of the organic layers is a superhydrophobic layer.

19. The barrier film of claim 18 wherein the superhydrophobic layer includes fluororalkylsilane.

20. The barrier film of claim 12 wherein the organic layers are made from polymer precursors to which one or more one or more hydrophobic groups have been added.

21. The barrier film of claim 20 wherein the one or more hydrophobic groups are selected from the group of non-polar hydrophobic groups, methyl groups, benzyl (aromatic) groups, PO_4^{3-}, SO_4^{2-}, CH_3COO^-, Cl^-, Br^-, NO^-, ClO_4^-, I^-, SC_n^- anions, NH_4^+, Rb^+, K^+, Na^+, Cs^+, Li^+, Mg^{2+}, Ca^{2+}, Ba^{2+} cations, tryptophan, isoleucine, phenylalanine, tyrosine, leucine, valine, methionine, and alanine.

22. The barrier film of claim 12 wherein the barrier film is made from a sol including one or more Gemini surfactants.

23. An article of manufacture, comprising:
an object having a surface; and
an inorganic/organic hybrid nanolaminate barrier film of the type set forth in claim 12 disposed on the surface.

24. The article of manufacture of claim 23 wherein the object is selected from the group of optoelectronic devices, LEDs, solar cells, FETs, lasers, pharmaceutical products, tablets in packages, medical devices, food products, packaged foods, beverages, candies, display screens, touch panel displays, flat panel displays, electroluminescent windows, windows, transparent films and coatings, electronic components, and chassis for appliances used in rugged environments.